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ABSTRACT

Personal Learning Environments (PLEs) enable lifelong learning and make competences visible in education and professional life. This paper illuminates how to design an online learning process that enables deep learning through PLEs based upon our study of a scaffolding process supported by Web 2.0 tools. Professional student teachers developed their own blogs as PLEs, and we collected data from five student teacher groups. We employed the DIANA pedagogical model to design a dialogical, collaborative, and authentic learning process before comparing its activities against the activities of the five-stage model for scaffolding designed for online learning processes. The results indicate that the DIANA model includes the elements of the five-stage model, and it appears that teacher scaffolding is particularly important in student PLEs. These findings provide insights to other practitioners seeking to design and implement online learning processes that are based on collaborative knowledge construction utilizing students' Personal Learning Environments.

Keywords: online learning; personal learning environment; scaffolding; pedagogy; web 2.0 tools

1. Introduction

In professional education today, learning has become blended in every environment, requiring dialogical, collaborative, and online activities. In isolation, learning management systems (LMS) at educational institutes are insufficient for collecting and storing all of the learning materials and processes. Learning products remain on institutions' LMS servers and usually cannot be exported to any other system; thus, they do not support lifelong learning. Due to this limitation, students should be encouraged to develop their own digital learning environments in so-called Personal Learning Environments (Wheeler 2015; Vuojärvi 2013; Fiedler 2013). Although Personal Learning Environments (PLEs) involve new technologies for learning, the approach is not simply technical; rather, it is based on philosophical, ethical, and pedagogical considerations (Attwell 2007; Castaneda and Adell 2013). In line with these thoughts, teachers require new tools to scaffold students in these personalized learning environments.

This study focuses on Web 2.0 tools, which serve as the technological foundation for the PLE. Web 2.0 is concerned with the human aspects of collaboration and dialogue; it includes creating and sharing through the use of technologies like blogs, wikis, streaming videos, social networks, open-access sites, and socially-driven content (Abram 2007). These types of tools form an essential part of contemporary learning environments, and they can be integrated into many types of learning environments.

In the context of this study, PLEs are used to train student teachers in professional teacher education. Typically, the student teachers have to deal with authentic learning situations in their workplaces, a setting requiring collaborative knowledge construction (Paavola and Hakkarainen 2005.) According to Muukkonen et al. (2003), the collaborative knowledge construction learning

process is visible to all participants because they must exert continuous mental effort to learn and understand information. This visibility is also essential for the teacher seeking to scaffold students individually and/or collaboratively during the learning process. A proper pedagogical model must be followed in order to design a learning process that supports collaborative knowledge construction for online learning in a professional education context and this kind of pedagogical approaches are under studies (Barajas and Frossard 2017).

This study utilizes the DIANA model (Aarnio and Enqvist 2016) because it combines authentic, dialogical, and collaborative learning in online learning environments. In several of their studies, Aarnio and Enqvist (2004) have concluded that the DIANA model provides students in a teacher education context with several skills, including problem solving with known facts and new information, collaborative problems-solving skills, and innovative solution-finding skills. Based on the three elements of authenticity, the model involves dialogical and collaborative knowledge construction. Initially developed as a pedagogical model, it is also suitable for online learning processes (Aarnio and Enqvist 2016). Despite these advantages, recent studies have revealed a need to improve student-centered scaffolding and guidance (Aarnio 2006; Ruhalahti et al. 2016; Teräs 2016). Meanwhile, Aarnio's (2006) study noted that further research is needed into the structure of online learning processes. During her research, Aarnio found that it is challenging to structure a learning process following the DIANA model; if not designed carefully, the learning process might lose authenticity and dialogue. Additionally, the PLE philosophy seems conducive to the DIANA model, because in a learning process following the DIANA model there are structured activities related in preparation of dialogical activities as well as structuring a collective work. By these activities it is time to clarify PLE philosophy to students. In addition the DIANA model is very flexible with used learning environments although requires collaborative environments that PLEs can be.

Scaffolding is a frequently studied subject in education. In fact, the concept has been adapted so widely that many believe it has become diluted and unclear (van de Pol et al. 2010). Recent studies have found that students need a teacher's facilitation in order to utilize the PLE philosophy properly for learning purposes (Rahimi et al. 2012; Rahimi et al. 2015; Valtonen et al. 2012); this facilitator role may be viewed as part and parcel of scaffolding activities. This research explores scaffolding activities by applying a scaffolding model for online learning, the five-stage model for teachers/facilitators (Salmon 2003). Ultimately, using PLE in collaborative knowledge construction requires pedagogical framing and a scaffolding model with sufficient web tools. This study aims to investigate the scaffolding process used within a pedagogical model while also exploring scaffolding tools.

The study follows the methodology of Design-Based Implementation Research (DBIR) (Fishman et al. 2013). The expectation was that the methodology would respond to the research questions most accurately because the DBIR enables one to modify the study process according to results, thus allowing the study to continue in a new and different direction. The data was collected from five groups of professional student teachers that all studied in the same online course following the DIANA pedagogical model by Aarnio and Enqvist (2016). With the fifth group, we used Salmon's (2003) five-stage model for scaffolding. We then compared activities according to these two models in order to analyze the teacher's role in the learning process. These models will be defined and described in the following section, along with DBIR. The paper then moves into a discussion of the research analyses before providing a summary of the findings and a discussion.

2. Literature review

Learning processes cannot simply be moved to online settings from the classroom—online learning requires its own set of pedagogical approaches (Goodyear 2002; Bong and Cummings 1988).

However, it should not be assumed that completely different pedagogical models are required when moving learning from the classroom to the Internet. Instead, a variety of web tools are necessary to support effective teaching methods (Mayes and de Freitas 2013) and teachers need more knowledge of combining web tools and pedagogy (Olofsson et al. 2017). Students can have the freedom to choose their Personal Learning Environments themselves, thus gaining responsibility for their own learning in general. Nonetheless, teachers must still design, implement, and guide the learning process. Generally speaking, teachers are still looking for pedagogical models that utilize better web tools (Agostinho et al. 2013). The following paragraphs will provide a further discussion of this type of merged model, including pedagogical design, scaffolding, and web tools.

2.1. PLE and collaborative knowledge construction

There is no consensus regarding conceptualizations of the Personal Learning Environment (PLE) and the tools that best support learning in these environments. PLEs increasingly are being used in the context of personal development independent of learning activities, and they are continually extending beyond the realm of formal education (Fiedler and Völjätaga 2013). In the context of professional education, blended learning environments means learning through both formal and informal contexts. According to Marsick et al. (2006), 70% of a person's learning occurs incidentally in informal learning environments. For example, informal learning occurs at work, with family members, and while doing hobbies (Galanis et al. 2016). Obviously, teachers cannot physically participate in all learning situations; therefore, digital tools can help teachers follow and guide students' learning. Collaborative knowledge construction and competences need to be transparent in digital environments, using suitable web tools that students may carry with them during their lifelong learning journeys. In the future, PLEs will become even more central to learning (Castaneda and Adell 2013).

According to Rahimi et al. (2012), social media tools (also called Web 2.0 tools) should be integrated into active learning processes in order to enable student-centered and collaborative learning based on the idea of a Personal Learning Environment. Indeed, college students want to use search engines, videos, and social networks for learning (Dabbagh and Fake 2017). PLEs also allow students to exchange their work and to access supportive information more quickly. Through online activities, they become autonomous, driving their own learning (Fonseca et al. 2016). As Dabbagh and Kitsantas (2012; 2013) found, the PLE is a potentially promising pedagogical approach integrating formal and informal learning that supports students' self-regulated learning while also utilizing social media tools in higher education. However, Sahin and Uluyol (2016) found that PLE use tends to focus more on access and sharing rather than knowledge construction.

Knowledge construction demands social interaction throughout the learning process (e.g., Wenger 1998; Vygotsky 1978). This concept is closely linked to participation and action in communities of practice (Wenger 1998), where members of the learning community share a goal and contribute new knowledge in order to create a common understanding through interaction. Researchers have found collaborative learning with peers to be a successful way of learning, utilizing small groups to construct knowledge by interlocking students' social and intellectual capacities (Michalsen and Sweet 2011). Personal Learning Environments seem to provide a strong platform for collaborative learning and knowledge construction. Meanwhile, collaborative web tools between a teacher and students may allow students to better demonstrate their receptiveness of a new information (Fonseca et al. 2016). An important note should be added here: even though we are discussing PLEs, we are not insinuating that a student should use them in isolation during the learning process. Personal learning networks and personal web tools are important parts of PLEs, and they are essential components of collaborative learning. Taken together, they create personal learning. (Wheeler 2015.) To enable these circumstances, a pedagogical model that utilizes collaborative,

authentic, and online learning should be implemented in order to complete the learning process. As such, the following section introduces Aarnio and Enqvist's (2016) DIANA model.

2.2. DIANA as a pedagogical model

Professional teacher education requires authenticity and collaborative knowledge construction; in this particular context, the learning also had to take place online, making the DIANA model (Dialogical Authentic Netlearning Activity) applicable. The DIANA model has proven suitable in the Finnish professional teacher education setting because it provides opportunities for authentic, dialogical, and collaborative learning, ultimately leading to deep-oriented learning (Ruhalahti et al. 2016; Ruhalahti et al. 2017). The revised DIANA model by Aarnio and Enqvist (2016) includes four cornerstones to be followed in the learning process. While cornerstone A creates a common ground for collaborative learning, cornerstone B enables authentic learning. Cornerstone C transfers the learning towards deeper-oriented learning through dialogical actions. In cornerstone D, theory and practice are integrated into learning situations, and the learning is deepened. If possible, the learning may start over again from cornerstone B. Table 1 provides more explanation regarding these cornerstones.

Table 1.

The structure and learning activities of the “network in vocational education” module, based on the revised DIANA model (Aarnio and Enqvist 2016).

Cornerstones of the DIANA model	Operative dimensions
A. Creating a common ground for collaborative learning	A1. The idea of authentic and dialogical learning A2. Preparing for dialogical participation in the learning community A3. Structuring and starting the collective work
B. Enabling the authenticity in learning	B1. Deriving authentic learning tasks, learner-centred from real life and work situations, formulating and inquiring open learning questions using the language used by students, the starting point being their everyday conceptions B2. Using authentic sources and materials or data to create content and products
C. Increasing deep-orientated learning through dialogical actions	C1. Inquiring and constructing knowledge through dialogical actions C2. Working as equals, participating reciprocally and symmetrically, listening to others, open and constructive inquiry, and weaving syntheses C3. The focus is on open, inquiring questions which are used to find solutions and create content
D. Integrating theory and practice in learning situations	D1. Alternating theory and practise, weaving a synthesis, finding gaps in thinking and actions, formulating new questions on the basis of those gaps D2. Continuous reflection and evaluation throughout the learning process – individually and collectively

The DIANA model focuses on the pedagogical aspects of learning — scaffolding was not its original focus. The next section describes a scaffolding model created for the context of the online learning process, making it a suitable companion to the DIANA model.

2.3. The five-stage model for fostering scaffolding activities

Scaffolding is the teacher guidance given to a student based on his or her individual need for support in achieving learning goals that might otherwise be unattained (Wood et al. 1976). Scaffolding is also used as a synonymously with support (Puntambekar and Hübscher 2005). Scaffolding means applying the right amount of structure to a learning environment by acknowledging learners'

different needs, from no structure to highly structured. A teacher needs to be aware of students' prior knowledge in order to provide the needed scaffolding (Dabbagh 2003). Behind scaffolding activities there exists 1) an assumption that (learning) goals are understood and valued by students—though these goals might be beyond their current levels of individual proficiency; 2) a teacher (adult) provides assistance according to his or her diagnosis of a student's understanding and/or skill level; 3) a teacher can give a range of support depending on the nature of the tasks; and 4) the teacher's scaffolding activities are temporary (Stone, 1998). Related to Stone's (1998) metaphor of scaffolding, Palinscar (1989) adds a very accessible description due to its flexibility and inclusion of multiple teaching dimensions. Though it should be handled with care in educational research, it can be adapted easily into teaching practices. Scaffolding includes several dimensions of activities. It is competence-based and includes former knowledge. Finally, it usually goes hand-in-hand with the learning process. Scaffolding may also be collaborative while students participate in guiding their peers during a learning process (Donato 1994).

From a social-constructivist perspective, scaffolding brings personal meaning into learning (Palinscar, 1998). It is rooted in Vygotsky's (1978) model, which explains the teacher's role as a more knowledgeable learner who helps students solve problems within their zones of proximal development (ZPD). Vygotsky (1978) formulated the ZPD model in two parts. Actual development level (ADL) refers to where students can work and learn on their own. The potential development level (PDL) is a higher level of possible development determined by problem solving under guidance or in dialogue with peers. A teacher must deconstruct the learning actions within the learner's zone of proximal development, provide sufficient practice for improving performance, and give meaningful feedback (Laurillard 2012). In addition, the teacher needs to design activities that will encourage students to construct their knowledge using web tools (Ludvigsen et al. 2016). Following multiple techniques, online learning practices have become a new forum for scaffolding (Dabbagh 2003).

In the 1990's Gilly Salmon began action research into scaffolding for online learning processes. The five-stage model is the result of this research (Salmon 2003). Salmon (2003) uses the terms e-moderator and e-tivities designer (Salmon 2013) to describe the online teacher who scaffolds using digital technologies when conducting online learning processes. Salmon's (2003) five-stage model for scaffolding is based on different dimensions of asynchronous online learning, including social interaction, motivation, and learning with information and communication technology (ICT). The stages of the five-stage model provide an introduction to teachers on how to scaffold their learners during online collaborative learning processes in order to increase students' independence while encouraging responsibility for their own learning processes (Salmon 2003). The first stage of the model involves setting up the system, including accessing, welcoming, and encouraging students. The second stage includes socializing with online learners: sending supporting messages and providing bridges between the cultural, social, and learning environments. The third stage is to exchange information: searching for and personalizing software, facilitating tasks, and supporting the use of learning materials. The fourth stage involves constructing knowledge by conferencing and facilitating learning processes. In the fifth stage, the teacher supports student development by providing further information and resources for learning. At higher stages, the students become more independent and are responsible for their own learning. Table 2 describes these stages in greater detail.

Table 2.
The five-stage model of online scaffolding (Salmon 2003).

Five-stage model	
1. Access and motivation	Setting up the system Accessing, welcoming, and encouraging
2. Online socialization	Sending and receiving messages

	Familiarizing and providing bridges between cultural, social, and learning environments
3. Information Exchange	Searching, personalizing software Facilitating tasks and supporting the use of learning materials
4. Knowledge construction	Conferencing Facilitating process
5. Development	Providing links outside closed conference Supporting, responding

Appropriate web tools are needed to successfully implement a pedagogical and scaffolding model that supports learning in PLEs with a proper scaffolding process. According to Puntambekar and Hübscher (2005), online scaffolding requires web tools that provide procedural support. Web tools provide help with complex tasks by constraining the tasks, by organizing arguments and scientific explanations, and/or by making the learning process and knowledge construction more transparent. The following section describes the web tools used in the present study.

2.4. Web tools as personal learning environments

The PLE is not a technology; however, technology is needed in order to support learning in PLEs. Students must be familiar with the tools to choose which ones are appropriate for learning in PLEs. In today's parlance, a PLE generally is understood as a collection of ICT tools that support a collaborative online learning process; it is not just one tool (Valtonen et al. 2011). According to Bassani and Barbosa (2018), the criteria for selecting PLE web tools include gratuity, age, hybrid access mode, communication type, and visibility. Blogs and wikis are examples of strong tools that combine content generating and sharing (Bassani and Barbosa 2018; Wheeler 2015). Importantly, blogs, for example, serve several functions (e.g., blog, wiki, site, discussion forum); they are many tools in one (Bassani and Barbosa 2018). Web tools may be social networks, distribution channels, and media archives at the same time (Beetham 2013). Such open social software enables students to collaborate, interact, and create online communities (Özkan and McKenzie 2008).

Blogs are popular PLE tools, serving as shared environments for collaborative knowledge construction (Aramo-Immonen et al. 2015; Sahin and Uluyol 2016; Yang et al. 2016). According to Deng and Yuen (2011), blogs make educational affordance an expressive, reflective, and collaborative medium among student teachers. Yang et al. (2016) add that cognitively effective blog learning requires active dialogue between peer students and the teacher, the discussion moderator. These researchers also found that blogs, as learning environments, cause students to ask several questions and post comments indicating the presence of strong social interaction. The researchers concluded that cognitive presence plays the most important role in blog-based learning courses. Even though discussion forums allow concentrated, meaningful discussion of the course content, further research is needed to improve scaffolding through tools that enhance learning outcomes (Yang et al. 2016).

In teacher education, it is important to give student teachers experiences with new learning environments. According to Goktas and Emirel (2012), the use of blogs in education develops student teachers' awareness and fosters a positive attitude towards using ICT in education. They also found that blogs function as a form of scaffolding by developing students' higher-level thinking skills. Blogs offer opportunities for students to become self-directed learners with specific learning activities, such as generating learning goals, planning how to tackle problems, evaluating whether the learning goals have been met, and re-planning based on this evaluation (Robertson 2011; Wang and Woo 2010). Finally, according to Tang et al. (2014), blogs increase student satisfaction, self-efficacy, experiential learning, and continuance of intention to learn.

Blogs may be collaboratively produced, and comments may be used as a discussion forum. However, short and instant messages are needed to carry on and move forward a collaborative learning process. Quick questions and answers are easier to manage in messaging tools like WhatsApp or closed Facebook groups. These types of web tools are very collaborative and social for learning activities with private groups of students. According to Bouhnik and Deshen (2014), WhatsApp improved learners' interactions by promoting a social atmosphere, fostering dialogue, and increasing sharing with peers. Karpanos et al. (2016) also suggest that WhatsApp is a popular web tool (media) enabling individual and targeted media instead of open sharing online. When using these kinds of instant messages, communication is usually asynchronous. Every now and then, a conference call is needed to foster communication between the teacher and students. According to Kras and Hedberg (2010), web-conferencing increases teachers' comments and guidance significantly while encouraging student participation in collaborative dialogue. However, such conferencing needs to be prepared well, and students require activities in order to engage in knowledge construction during an online conference meeting (Kear et al. 2012).

This study utilized a blog tool for the teacher's environment because it allows the easy sharing of content and learning tasks while scaffolding students in many ways. It was also a meaningful way to provide student teachers experience with using a blog as a collaborative learning tool. WhatsApp and a closed Facebook group also were part of the learning environment because they provide good arenas for teacher and peer scaffolding; both the teacher and students could send messages. These tools were employed during different stages of learning following the DIANA model, a structured process of learning that requires teachers and students to interact during the entire learning process.

3. The empirical part

This section explains the research design by describing the cycles step by step. Because the study was a cyclic process, this section also includes the results that justify the subsequent steps. Described in Figure 1, the research design followed Design-Based Implementation Research. This study aimed to improve online learning activities with professional student teachers. For the learning design, we chose the DIANA pedagogical model because it aligns with PLE philosophy. Referring to earlier studies, scaffolding elements often are hidden or even missing in online learning processes. As such, the five-stage model was chosen because it is an online scaffolding model for teachers/facilitators.

design; c) a concern with developing theory related to both classroom learning and implementation through systematic inquiry; and d) a concern with developing capacity for sustaining change in systems (Penuel et al. 2011; Fishman et al. 2013; LeMahieu et al. 2017). DBIR allows researchers to ask broader question, such as “what works when, for whom, and under what conditions” (Fishman et al. 2013).

Figure 1 introduces the study design according to DBIR. This chapter explains the entire study design based on four principles (Penuel et al. 2011; Fishman et al. 2013). The research design proceeds according to the results, and therefore, this chapter explains the results as well as the data collection and participants at each step of the study design.

3.1. The context of the study and the course design

By studies in the School of Professional Teacher Education student teachers will have a teacher qualification to work among vocational education and training in upper secondary level and in university of applied sciences. In professional teacher education, there is a need to design online courses where student teachers actively participate using online tools for collaborative learning purposes. We needed to activate student teachers to become self-directed learners, allowing the teacher to focus more on the visibility of facilitating a learning process. The final users are student teachers’ students, the recipients of an efficient online learning design based on the results of this study. The professional teacher education program includes several aspects focusing on teachers’ pedagogical thinking and activities; therefore, it is important to maintain an ongoing discussion of improvements in this area on the organizational level in the School of Professional Teacher Education. The student teachers were involved in the study by taking the course (implementation in Figure 1), and their experience was analyzed (analyses in Figure 1). Student teachers are an important group of stakeholders, improving the online learning process with the pedagogical model, the scaffolding, and the web tools.

The first two authors of this article collaborated on the course design, data collection, and analyses. They work as teachers and researchers in the same organization. The third author supervised the DBIR process as an outsider of the organization. The two first authors both had two groups of students related to the first implementation (groups 1-4), and the first author continued with an additional implementation (group 5).

The data were gathered by the two first authors. They are long-standing members of the staff in the School of Professional Teacher Education and very familiar to organize student teachers studies. Study participants were informed that collected data would be used in the study. They were also informed that the participation was voluntary and they had a right to withdraw from the study at any stage. The collected data by the questionnaires were anonymous. The research organization follows good working practices also in research activities and data protections is taken into account by legislation. Part of the data is open online as the nature of the research was to understand how to use open web tools for educational purposes. The open part of the data are teachers’ blogs. The questionnaires and WhatsApp discussion were stored in organization’s secure server anonymously.

The study was integrated into student teachers’ studies of their teacher education. With student teachers it was conducted a detailed discussion of using open web tools that are not owned or controlled by the School of Professional Teacher Education. It was explained that student teachers were not obliged to use web tools that are offered by external organizations. These kinds of tools used in the study was for example Google applications, blog tools (e.g. Wordpress, Blogger), WhatsApp and other tools student teachers personally considered to be relevant in their studies.

However, the alternative was given to student teachers in case they did not want to use open web tools. They were informed the digital tools that are owned and controlled by the School of Professional Teacher Education. All student teachers used voluntary open web tools and organizations' closed digital tools were not needed.

The learning design was developed for the four student teacher groups who studied using an online course called "Networks in Professional Education." These learning processes took from four to five weeks each. Three of the four implementations included contact lessons, while the remaining course was based on online learning. Before the course took place, student teachers had studied different web tools in order to get ready for an online learning process utilizing PLE philosophy. Similar to Ruhalahti et al. (2017), we wanted the learning process to follow the DIANA model using each of its cornerstones (Aarnio and Enqvist 2016; please see Table 1). The course started from cornerstone A: students created a common ground for authentic and dialogical learning. The learners were introduced to the idea of authentic dialogical learning, the learning process, and web tools. The participants were divided into small study circles and expected to create a shared blog to document their learning processes. However, the study circles were free to decide on the web tools they wanted to use to support their dialogical collaborative knowledge construction. The facilitator's role was to ensure that students were progressing in their learning journey and to provide scaffolding with the help of the blog and web tools. Cornerstone B deepened the individual and group processes of finding and formulating authentic questions based on the learning objectives of the course. Each student individually devised his or her own authentic questions connected to the course's learning objectives. Thereafter, the students formulated shared authentic questions and categorized them into themes. Both the questions and themes were published on the students' blogs. In addition, students decided on the kinds of artifacts they would produce during the learning process. The facilitator's role was to offer scaffolding and to guide learning in the right direction. During cornerstone C, students constructed knowledge with dialogical activities about the subject being studied. Cornerstone D involved artifacts, including presentation, peer assessment, and self-assessment. Students also searched for missing pieces in their artifacts related to learning objectives.

The teacher's instructions and the course material (readings and videos) were placed in the teacher's open blog (Blogger). The teacher kept a so-called "teacher's blog" for general messages, such as longer instructions regarding the learning process, advice related to the content, and reflections on the current status of the study circle's progress.

The entire study circle used the mobile application WhatsApp, including the teacher. WhatsApp was used to give brief and instant instructions and reminders about practices during the learning process. WhatsApp improves interaction by promoting a social atmosphere, fostering dialogue, and increasing sharing. In addition to WhatsApp, a closed Facebook group served the same purposes. While cornerstone B of the DIANA model has proven to be a difficult part of the learning process, the teachers organized a web conference in order to comment on assignments (authentic questions formulation) and to clarify the learning process. Students were active participants, presenting their assignment (authentic questions formulated) and suggesting new ideas after the teacher's instructions.

3.2. Analysis of RQ 1.1.

Students had the chance to adopt web tools in their own learning processes in order to estimate 1) how they used these tools in the course and 2) how these tools could be a part of their own teaching practices with their students (analyze RQ. 1.1. in Figure 1.). Sixty-three (43 female, 20 male, aged

between 28 and 57) student teachers at the School of Professional Teacher Education participated in the study, and the data were collected from 2014–2015. Figure 1 provides more details regarding this data.

Data for the study were collected using an online questionnaire (n=63). The questionnaire was designed according to the background theories related to the research questions. The survey included five multiple-choice questions about participants' use of web tools as well as their experiences related to use. There were also three open-ended questions concerning web tools and suggestions for further development. This questionnaire can be found in Appendix A.

We employed a qualitative deductive content analysis (Johnson and Christensen 2008, p. 534; Bogdan and Biklen 1992) to discover relationships between the data and existing theories regarding PLE, web tools, scaffolding, and collaborative knowledge construction. The content analysis followed these steps: a) the data were reduced, b) the data were regrouped, c) the data were categorized, and d) the data were used to generate conclusions. The first two authors read the data independently several times and important passages were coded into categories according to PLE theory, knowledge construction, and scaffolding. Words, phrases, and sentences were used when coding the data. The first two authors of this article compared and discussed their coding and arrived at agreement.

3.2.1. The findings

According to the questionnaire, 52 of the 63 student teachers found the blog to be a sufficient learning environment that enabled the teacher's scaffolding. 55 student teachers found the blog to be a suitable collaborative learning environment for study circles. The majority of student teachers (37) failed to use other environments in their learning process although there were occasional exceptions; for example, some used tools like Moodle, Optima, Google Drive, Google Sites, Instagram, Wikispaces, and Wordpress.

There were 15 study circles during the first implementation of the study and four in the second. Eighteen study circles used the blog tool, Blogger (Google); only one study circle used a Wordpress tool. The study circles chose the tool they wanted to use themselves.

Thirty-five student teachers found that they became more able to use web tools in their own teaching work after the study module. The student teachers also felt that they would utilize web tools in their own work for scaffolding (17) and teaching (19).

For general scaffolding and information sharing during the learning process, the entire group used WhatsApp. The student teachers' opinion was that WhatsApp was a good (29) or quite good (13) tool for short bursts of information sharing.

After obtaining these results, there remained questions regarding the usability of web tools during the online learning process. Some details regarding scaffolding activities also remained obscure, leading to the next analysis of RQ 1.2.

3.3. Analysis of RQ 1.2.

Following the DIANA pedagogical model, the course design developed after each iteration with groups 1-4. Teachers reacted to students' actions during the course implementations and modified the course design accordingly. To analyze RQ 1.2., we collected information about best practices in

online courses four times with different groups of professional student teachers. All of the teacher's activities and web tools were listed and categorized according to the DIANA model. The first two authors then analyzed the course implementation through the lens of the five-stage model (Figure 1). The activities were collected from the teacher's blog, the study circle blogs, and WhatsApp messages. Appendix B includes all of these activities (DIANA and five-stage model in course design), and Figure 1 describes the data. Finally, the data were categorized by each cornerstone of the DIANA model, and the entire process was analyzed again using the five-stage model.

3.3.1. The findings

In order to ascertain whether or not the DIANA model includes scaffolding elements, the activities of the five-stage model were compared with the activities of the DIANA model. Several activities followed both the DIANA model and the five-stage model. While the DIANA model concentrates on deep learning using certain dialogical activities, the five-stage model focuses on the teacher's online activities in general. The DIANA model includes all scaffolding activities in the five-stage model.

The implication comparing activities of the models is that both models support strict activities, where the teacher is a manager, moderator, and facilitator; in this sense, the teacher enables a collaborative and dialogical (social) learning process with the target of knowledge construction. Throughout the learning process, both models allow space for a learner to become self-directed with the aim of creating autonomy by the end of the course.

In Table 3. we describe stages of the Five-stage model that relates to the cornerstones of the DIANA model. The conclusion we withdrawn from the comparison introduced in Appendix B. The stages of the Five-stage model were conducted several times during the learning process that follows the DIANA model.

Table 3. The five-stage scaffolding process with the DIANA model.

DIANA model	Five-stage model
A. Creating a common ground for collaborative learning	1 Access and motivation 2 Online socialization 3 Information Exchange
B. Enabling the authenticity in learning	1 Access and motivation 2 Online socialization 3 Information Exchange 4 Knowledge construction 5 Development
C. Increasing deep-orientated learning through dialogical actions	2 Online socialization 3 Information Exchange 4 Knowledge construction 5 Development
D. Integrating theory and practice in learning situations	2 Online socialization 3 Information Exchange 5 Development

This comparison in Appendix B. also demonstrates a need for general, whole-group scaffolding as well as individual scaffolding according to the two models. To summarize, it seems that simultaneous, general scaffolding is needed for the whole group in order to facilitate the collaborative learning process. At the same time, the study circles require their own scaffolding in each cornerstone of the DIANA model to move the learning process forward.

3.4. Redesign and implementation

The analyses (RQ 1.1. and RQ 1.2., see Figure 1) implied that the scaffolding process presented in the five-stage model actually restarts within all cornerstones of the DIANA model—they do not follow a single scaffolding process throughout the whole DIANA model. Table 3. introduces the process of the pedagogical model and scaffolding results according to RQ 1.2. The redesign concerned scaffolding activities following the five-stage model with several activities in each cornerstone (A, B, C, and D) of the DIANA model. This finding gave rise to the question of which web tools were used and which points were critical to scaffolding. Using this information, group 5 received a new implementation (see the Figure 1). The course design followed the first implementation (Groups 1-4) as well as the course design mentioned in section 3.1. In this design, we devoted special attention to each stage of the five-stage model of scaffolding for each cornerstone of the DIANA model, as described in the results sections for RQ1.1. and RQ1.2.

Thirteen student teachers (10 female, 3 male) at the School of Professional Teacher Education, aged between 36 and 56, took part in the second implementation. The course was entitled “Networks in Professional Education.” Taking place in 2016, the course again was presented online with two classroom learning sessions.

3.5. Analysis of RQ 1.3.

Evaluation (RQ 1.3., see Figure 1) focused on the cornerstones of the DIANA model, searching for answers regarding scaffolding activities through web tools. The data were collected during the learning process in 2016 via four questionnaires administered after completion of each cornerstone (A-D) of the DIANA model (Figure 1). Appendix C presents the questionnaire used to collect process data. All of the items were multiple-choice questions, and the data were analyzed based on the four questions.

3.5.1. The findings

The results indicate that the teacher’s scaffolding was needed to ensure successful, beneficial dialogue and collaborative work in the small study circles’ blogs at each cornerstone of the DIANA model. In cornerstone A, the most important scaffolding activity was the static instructions provided in the teacher’s blog. In cornerstone B, there was a need for general teacher instructions in his/her blog texts and in the study circle’s blogs. During cornerstone B, the teacher conducted an online Webex meeting, and the students found it very helpful in answering their authentic questions. In cornerstones C and D, students indicated that the teachers’ comments on the study circles’ blogs were very important.

The results also indicate that teachers’ comments on the study circle’s blogs were the most useful way to advance learning. Students mentioned that these comments were the best and most necessary ways to scaffold from cornerstones B to D.

Referring to other web tools for the learning process, the entire study circle used WhatsApp. After each cornerstone of the DIANA model, 50% of the students responded that WhatsApp was an important tool during cornerstones A, C, and D. The small study circles also used WhatsApp as a small group tool, and half of the respondents found that it was most useful during cornerstone C.

Finally, the results also indicated that students took part in collaborative work well, especially during cornerstones A, C, and D. The results are similar for the question of how well students participated in dialogue on each other’s work in the study circle blogs.

5. Discussion

The purpose of this study was to discover what scaffolding means when Personal Learning Environments are used in an online learning process context. Previous studies have shown that a proper pedagogical model is needed when designing an online learning process (Goodyear 2002; Bong and Cummings 1988). Professional education emphasizes authentic and dialogical activities, as well as collaborative knowledge construction; therefore, we chose Aarnio and Engqvist's (2016) DIANA model to design an online learning process. This model was compared with Salmon's (2003) five-stage model to discover how scaffolding can support deeper learning. The online learning process was supported by a blog tool that enabled collaborative learning.

This study also explored web tools for the online learning process in order to find suitable ones. A blog is said to be a collaborative tool for combining content construction and sharing (Bassani and Barbosa 2018; Wheeler 2015; Özkan and McKenzie 2008); it also is seen as a very popular tool to support learning in Personal Learning Environments (Aramo-Immonen et al. 2016; Sahin and Uluyol 2016; Yang et al. 2016; Quadir and Chen 2015). The findings of this study support previous research because student teachers found blogs to be excellent PLEs during the course. Although many other Web 2.0 tools could be used to support learning, the blog tool seems to be sufficient for learning purposes, even in collaborative situations. The Google Blogger tool appears to be particularly useful for this kind of online learning due to its ease of use and intuitive nature. Student teachers also found the teacher's blog significant and supportive of their learning purposes. In addition, using a blog promoted a positive attitude toward ICT use in education, as suggested by Goktas and Demirel (2012). Even though the student teachers indicated that they could utilize web tools in their own scaffolding and teaching work following the course, it seems that more enthusiasm is still needed for using blogs as a teaching and learning tool according to the results that only 30% felt readiness to use blogs in their teaching or scaffolding work.

Web 2.0 tools are also useful as Personal Learning Environments in collaborative learning processes. This study does not confirm Sahin and Uluyol's (2016) finding that PLE use focuses more on access and sharing purposes than on knowledge construction. During this study of online learning processes utilizing PLE philosophy, we noticed that learning activities and teacher scaffolding produce collaborative knowledge construction in students' personal learning environments. However, we also acknowledged that PLEs were used for sharing purposes.

This study primarily aimed to discover how and by what means student teachers can be scaffolded when studying in Personal Learning Environments. The results of this study indicate that elements of scaffolding exist in the DIANA model (Aarnio and Engqvist 2016). Earlier studies have shown that more scaffolding is needed during learning processes, and studies related to the DIANA model have presented similar findings (Ruhalahti et al. 2016; Ruhalahti et al. 2017). We employed a method of investigating scaffolding activities during the pedagogical DIANA model and the five-stage model of scaffolding in order to compare the activities in these two models. A comparison of activities in these two models shows that the DIANA model actually includes all the same activities as the five-stage model for the scaffolding process. However, it also shows that the scaffolding activities of the five-stage model need to be repeated in each cornerstone of the DIANA model. This finding leads us to conclude that teachers must be prepared for ongoing scaffolding during the entire learning process even when following a pedagogical model.

In order to support a collaborative learning process using the DIANA model, the following is needed: 1) general scaffolding for the whole group using the teacher's blog texts and WhatsApp messages and 2) scaffolding by each study circle for each cornerstone of the DIANA model. The five-stage

scaffolding model provides general instructions on an online facilitator's role. Online learning requires that one proceed with the deep learning process following a pedagogical learning model. As the PLE is a potentially promising pedagogical approach integrating formal and informal learning as well as social media tools (Dabbagh and Kitsantas 2012; 2013), it was easy to adopt following the pedagogical DIANA model. In cornerstone A, the DIANA model allows space to familiarize oneself with the learning environments while collaboratively creating rules for the learning process. For future studies, it might be interesting to compare other pedagogical models with the five-stage scaffolding model, particularly when PLEs are used during the learning process.

This study also aimed to find a place and time for scaffolding activities during a learning process that followed the DIANA model. We chose WhatsApp and Google Blogger because Personal Learning Environments today are most often used with Web 2.0 tools (Bassani and Barbosa 2018; Wheeler 2015). During the learning process following the DIANA model, we found that the most important and productive way to scaffold was through teachers' comments and assessment in the PLEs, the study circles' blogs. However, it also became clear that a general scaffolding process also was necessary for the whole group, because the entire group worked together collaboratively during cornerstones A and D. The teacher's blog served as a central hub for the learning process: it included material sharing, general instructions, and the teacher's reflections on the whole group. It also served as an example of how to use a blog as a teaching tool.

In addition to these tools, a tool for short messages and reminders was needed. WhatsApp enabled short messages and study circle communication between members. WhatsApp served as an easy and valuable tool for this need. Furthermore, additional tools are needed in an online learning space in order to create pictures, mindmaps, and other kinds of artifacts. Used tools were provided by Google Drive's picture tool, documents and tables as well as some mindmap tools were in use.

In general, it is both necessary and possible to scaffold students' learning process during online courses using PLEs. However, a proven pedagogical model is needed to facilitate the learning design, and extra attention should be devoted to scaffolding. A teacher should consider whether or not a chosen pedagogical model includes scaffolding elements; if not, he or she may need to devote more attention to this element during the learning process. PLEs seem to be very flexible for use in learning processes with the DIANA model; they also appear amenable to scaffolding. However, the teacher needs pedagogical and digital skills to operate effectively in PLE spaces. Future research might generate a coherent picture of teachers' digital competence.

Future studies also might investigate the artifacts that this kind of online learning process produces in order to visualize the personal synthesis of learned theory and practice according to the DIANA model. The artifacts produced in PLEs stay there as part of the lifelong learning process, and it is possible to refer to them whenever necessary. Further, student teachers' digital competence and the content of their own professional development can be investigated through their PLEs and portfolios.

The limitations of this study include the small sample size and the limited perspective used to address the collected data. For example, additional questions could have considered the student teachers' assumptions and expectations of the Personal Learning Environment philosophy. The study included only a small number of courses and iterations, which is also a limitation. Accordingly, this research was a small-scale study and cannot be generalized; however, it makes an important contribution to organizing the learning process when PLEs are used. The data were analyzed according to qualitative analyses methods, reflecting the introduced theories and increasing the validity of the study. Our research follows the key features of qualitative studies, which are interpretive, situational, reflective, flexible, inductive, and case-orientated (Schreier 2012). The

reliability of the study rests in the fact that the two first authors have analyzed the data independently. However, the study could have been more reliable if the data had been analyzed by someone not connected to the study. The principle of DBIR (Penuel et al. 2011; Fishman et al. 2013; LeMahieu et al. 2017) were followed with multiple stakeholders. By student teachers' answers in questionnaires the learning process progressed time after time. However, they could have taken in planning also by an interview or discussion.

For teachers, this study presents tools, methods, and learning processes that may be used successfully to collaboratively construct knowledge when students use PLEs online. The study provides insights into organizing online learning processes with student teachers in professional teacher education.

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Appendix A.

Source: created by the authors.

Original instruments in Finnish; translated into English for publication purposes.

Questionnaire RQ 1.1.

1. It was not only possible to participate in the course solely on a mobile device, but also on a traditional computer. Which apps did you use on your mobile device?
 - ☐ Blogger
 - ☐ WhatsApp
 - ☐ Google Drive
 - ☐ Facebook
2. Was the teacher's blog sufficient as the course learning environment and as the scaffolding channel?
 - ☐ Yes
 - ☐ No
 - ☐ I don't know
 - ☐ Other
3. What comments do you have concerning the teacher's course blog learning environment?
4. Was your study circle blog sufficient as a Personal Learning Environment?
 - ☐ Yes
 - ☐ No
 - ☐ I don't know
 - ☐ Other
5. What issues could be developed? Which other web tools could be suitable for the course in question?
6. How did the chosen web tools for communication (e.g., Facebook, WhatsApp) work among the whole study circle?
 - ☐ Well
 - ☐ Quite well
 - ☐ Quite poorly
 - ☐ Poorly
 - ☐ Other
7. How did the chosen web tools for communication work among your study circle? If you used some other communication web tools, please name it below under "other."
 - ☐ Well
 - ☐ Quite well
 - ☐ Quite poorly
 - ☐ Poor
 - ☐ Other
8. Please provide your comments on the web tools used.

Appendix B.

Comparison of the DIANA model and the five-stage model

Source: created by the authors.

Original instruments in Finnish; translated into English for publication purposes.

DIANA	Activities	Web 2.0 application	Five-stage model
A Creating common ground for collaborative learning	Teacher designs and creates an open learning environment with materials, instructions (also for web tools), and learning process.	Blogger (teacher)	1 Access and motivation
	Teacher writes welcome message with instructions for starting.	Blogger (teacher)	1 Access and motivation
	Study circles are formulated.	face-to-face / Webex	1 Access and motivation
	Teacher suggests some web tools for collaborative usage.	face-to-face / Webex	1 Access and motivation
	The learning process starts and web tools are selected.	face-to-face / Webex	1 Access and motivation
	Students give links to their PLEs. Teacher gives links from the teacher's environment to students PLEs.	WhatsApp	2 Online socializations
	Specific, relevant, and open learning materials (theory) related to topics are given in the teacher's environment, and students are instructed to read them.	Blogger (teacher)	3 Information exchange
B Enabling authenticity in learning	Teacher writes a blog text: "What are authentic questions and how do we formulate them?"	Blogger (teacher)	1 Access and motivation
	Students start to create authentic learning questions.	Blogger (students)	2 Online socializations
	Teacher gives authentic and supporting scaffolding in study circles' learning environments (blogs) related to composing authentic learning questions on the course topic in line with learning goals.	Blogger (students)	3 Information exchange
	Teacher engages all members of the study circles in discussion of knowledge building.	Blogger (teacher)	4 Knowledge construction
	Teacher makes assessments during the guidance process to encourage student progress.	Blogger (students)	4 Knowledge construction
	Teacher sends messages in WhatsApp, such as informative brief messages and reminders. Students ask questions and reply.	WhatsApp	4 Knowledge construction
	Teacher takes part in discussion in study circle blogs and makes the discussion relevant by referring to learning goals.	Blogger (students)	4 Knowledge construction
	Teacher asks students to compose learning questions related to real-life work situations based on theory.	Blogger (students)	5 Development
	Teacher requires all to attend to the discussion and knowledge-building process.	WhatsApp	4 Knowledge construction
	Teacher gives feedback and recognizes students' achievements.	Blogger (students)	5 Development
C Increasing deep-oriented learning	Blog text provides specific instructions for the learning task and use of learning materials. It also reflects on the whole study circle's development so far.	Blogger (teacher)	2 Online socializations

through dialogical actions			
	Through online discussion, the teacher asks further questions and gives new approaches to making the study circle work towards qualitative artifacts.	Blogger (students)	2 Online socializations
	Teacher asks students to answer their authentic questions with practical answers.	Blogger (students)	3 Information exchange
	Teacher reminds students about deadlines.	WhatsApp	3 Information exchange
	Some members of the study circles take on the role of facilitator to fulfill learning tasks.	Blogger (students)	4 Knowledge construction
	Teacher gives space to students for making artifacts.	Blogger (teacher)	5 Development
	Study circles independently complete artifacts.	Blogger, Google tools (e.g., Drawings) Mindmap tools	5 Development
D Integrating theory and practice in learning situations	Teacher gives instructions for peer-assessment and self-assessment, requiring a reflective approach.	Blogger (teacher)	2 Online socializations
	Students give peer-assessment.	face-to-face/Webex	3 Information exchange
	Students write responses and conduct self-assessment.	Blogger (students)	5 Development
	Teacher writes blog text about final grades and gives thanks for the course by reflecting on all actions.	Blogger (teacher)	5 Development

Appendix C.

Source: created by the authors.

Original instruments in Finnish; translated into English for publication purposes.

Questionnaire RQ 1.3. (process data after each cornerstone of the DIANA model)

1. What kind of scaffolding was needed in each cornerstone of the DIANA model to promote learning process?
 - ☐ Teacher's blog texts
 - ☐ Instructions in the teacher's blog
 - ☐ WhatsApp for the whole group
 - ☐ Discussion forum for the study circle (e.g., WhatsApp)
 - ☐ Comments of one's own study circle members in your own blog
 - ☐ Teacher's comments on the study circle's blog
 - ☐ Other
 - ☐ Webex meeting (conference call only during cornerstone B)
2. Did all members of the study circle take part in collaborative work?
 - ☐ Yes
 - ☐ No
 - ☐ I don't know
 - ☐ Other
3. Were all members of your study circle in good dialogue with each other on your blog?
 - ☐ Yes
 - ☐ No
 - ☐ I don't know
 - ☐ Other
4. Were teacher's comments and assessments helpful in your learning environment (blog)?
 - ☐ Yes
 - ☐ No
 - ☐ I don't know
 - ☐ Other